



Published in final edited form as:

J Occup Environ Med. 2017 November ; 59(11): e227–e230. doi:10.1097/JOM.0000000000001179.

Enhancing Worker Health Through Clinical Decision Support (CDS): An Introduction to a Compilation

Margaret S. Filios, MSc, RN¹, Eileen Storey, MD, MPH¹, Sherry Baron, MD, MPH², Genevieve B. Luensman, PhD¹, and Richard N. Shiffman, MD, MCIS³

¹. National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention (CDC), Morgantown, WV, USA.

². Queens College, City University of New York, Flushing New York USA

³. Yale University, New Haven Connecticut USA

Abstract

Objective: This article outlines an approach to developing clinical decision support (CDS) for conditions related to work and health. When incorporated in electronic health records, such CDS will assist primary care providers (PCP's) care for working patients.

Methods: Three groups of Subject Matter Experts (SMEs) identified relevant clinical practice guidelines, best practices, and reviewed published literature concerning work-related asthma, return-to-work, and management of diabetes at work.

Results: SMEs developed one recommendation per topic that could be supported by electronic CDS. Reviews with PCPs, staff, and health information system implementers in five primary care settings confirmed that the approach was important and operationally sound.

Conclusions: This compendium is intended to stimulate a dialogue between occupational health specialists and primary care providers that will enhance the use of work information about patients in the primary care setting.

Keywords

Clinical Decision Support; Electronic Health Records; Worker Health

BACKGROUND

In this issue of the *Journal of Occupational and Environmental Medicine*, a compilation of articles describes proposals to introduce computer-mediated clinical decision support (CDS) into primary care practices to assist providers in the care of working patients. These articles are intended to stimulate a dialogue between occupational health specialists and primary care providers that will enhance the use of work information about patients in the primary

CORRESPONDENCE TO: Margaret Filios, MSc, RN MFilios@cdc.gov Telephone: 304.285.5754, Facsimile: 304.285.6111.

REPRINT REQUESTS: Margaret Filios, MSc, RN Surveillance Branch Respiratory Health Division, National Institute for Occupational Safety and Health, CDC M/S 900.2 1095 Willowdale Rd Morgantown, WV 26505 MFilios@cdc.gov.

CONFLICTS OF INTEREST: Nothing to report.

care setting. This work is the product of a larger project of the National Institute for Occupational Safety and Health (NIOSH) to demonstrate the value and use of occupational information in electronic health records (EHRs). Timely presentation of information about work would assist providers in recognizing the complex relationship of work and health, including both the impact of disease and injury on the ability to work and the impact of work on disease and injury. Effective CDS that is delivered electronically offers “five rights”: the right information to the right person in the right intervention format through the right channel at the right time in the clinical workflow.¹

In November of 2016, there were 159 million adults in the U.S. civilian work force.² What people do at work and the environments in which they spend so much time have enormous impacts on health. From well-understood industrial exposures—such as asbestos or lead that lead to chronic lung disease and cancer or renal disease and neurologic damage—to increasingly recognized health risks in service industries—such as health care, where nursing assistants have the highest rate of musculoskeletal disorders among all occupations in private industry,³ work is an important factor to be considered when caring for patients. Recent data suggest that sedentary work is as great a risk factor for heart disease as tobacco use.⁴ The organization of the work environment can also influence workers’ health whether as a result of long or irregular hours of work, job insecurity due to increased temporary or contract labor arrangements, or job stressors associated with work overload and inadequate supervisory support, contributing to unhealthy behaviors and chronic diseases.⁵ Many if not most of the patient encounters resulting from these risk factors will first be seen by primary care providers, hereafter referred to as PCPs, and the CDS tools linked to EHR systems provide an opportunity to assist them in identifying these potentially modifiable work-related risk factors.

In 2011, NIOSH requested the Institute of Medicine (IOM) of the National Academies to examine the rationale and feasibility of incorporating occupational information in EHRs. The IOM’s Report concluded that incorporating occupational information in EHRs could improve both individual and population health.⁶ In response to this report, NIOSH has been engaged in a process to ensure that information regarding work is captured in EHRs in a manner that will make it useful to PCPs at the time of care, supportive of efforts of clinical units to improve the health of their patient populations, and useful for public health. NIOSH has drafted an information model of Occupational Data for Health (ODH), illustrating key data elements. The draft model includes data elements for current employment status and for current and past jobs, including industry (ie, type of business), occupation (ie, type of work), employment type (eg, self-employed, unpaid worker), work schedule, job duties, and potential exposures. The patient’s usual (longest-held) occupation and usual industry related to the usual occupation are also included, since these are relevant to understanding some conditions with a long latency period. The data elements collected can be as simple (eg, the combination of occupation and industry) or complex (e.g., including potential exposures) as desired. Modeling the data in a standardized manner will promote consistency across EHRs and make it easier to share this information.

EHR systems use CDS software to make available knowledge about appropriate care to PCPs, staff, patients, or other individuals to enhance health and health care, referencing

clinical guidelines, best practices, and research. Patient characteristics are used to trigger delivery of information relevant to care. The first stage of generating CDS tools is the creation of knowledge resources to serve as precursors for electronic CDS. Three of the articles included in this supplement describe the development of knowledge resources focusing on information about work that would assist PCPs in recognizing the relationship between work and health. Each knowledge resource describes the information from evidence-based guidelines and best practices that could be offered to PCPs and the decision logic that would be used to trigger delivery of the CDS. The authors of these knowledge resources drew on a systematic approach and existing resources, which are summarized here.

Developing CDS from Professional Guidelines

In order to make professional guidelines and best practice(s) systematic and replicable, they need to be clear, transparent and implementable within a health information system. With the introduction of health information systems, clinical guidelines and best practices that can be expressed as recommendations and presented through computer algorithms can be linked to characteristics of patients and clinical findings so that they become available to providers at appropriate times. Common principles can inform the development of guideline-based CDS, regardless of the subject. The BRIDGE-Wiz⁷ application is primarily intended for those who develop guidelines. It can be used to generate clear and unambiguous recommendations and link them to the quality of evidence supporting the recommendations and the expected level of adherence (based on recommendation strength). The electronic GuideLine Implementability Appraisal (eGLIA)⁸ tool is an application that can be helpful in identifying potential obstacles to effective implementation so that they can be addressed by the guideline developers or anticipated by CDS implementers (available from <http://medicine.yale.edu/cmi/glides/index.aspx>).⁸

Recommendations that are articulated in a standardized manner are easier to implement in an electronic environment. One approach is to frame them to answer the following questions: *When* (under what circumstances)?, *Who* (is the guideline's intended audience)?, *Ought* (with what level of obligation)?, to Do *What* (precisely recommended activity)?, to *Whom* (target patients)? Additional relevant information—such as *How* to perform the recommendation and *Why*—can be appended or linked. Clear articulation of recommendations increases the likelihood that they will be applied as intended.

The quality of evidence supporting each recommendation and the strength of each recommendation are important considerations. Clearly describing each of these can help providers understand, interpret, and apply the recommendations. These two qualities represent distinct concepts that must be weighed separately in preparing recommendations. Quality of evidence relates to the aggregate evidence supporting a recommendation and incorporates consideration of study type and conduct. Strength of recommendation requires an assessment of the balance or imbalance between anticipated benefits, risks, harms, and costs associated with the recommendation and leads to an expectation of adherence to the recommendation. Application of methodologic rigor and transparency also enhances the

validity, or degree to which the recommendations a) reflect the intent of the guideline authors, and b) the strength of evidence.

Assessing the Utility of a Knowledge Resources

The second stage of the CDS development process involves seeking input from those who are the target of the recommendations and potential users: PCPs and staff.

Recommendations must be implementable, or suitable for use, by health information systems and a good fit for use in a healthcare setting. The characteristics that impact the ease of implementing a recommendation include decidability (under precisely what conditions the recommendation is to be performed), executability (exactly what is to be done), validity, flexibility (the degree to which a recommendation permits interpretation and allows for alternatives in execution), effect on process of care, measurability, novelty/innovation (the degree to which a recommendation proposes behaviors considered unconventional by clinicians or patients), and computability (the ease with which a recommendation can be operationalized in an electronic information system).⁸ These characteristics are helpful in focusing CDS development efforts on recommendations that are ready for use in a clinical setting. Obtaining feedback about recommendations from PCPs and health information system implementers based on these characteristics is critical to understanding the challenges and barriers as well as facilitators that could limit or enhance the utility of a proposed CDS.

METHODS

With National Occupational Research Agenda funding, NIOSH designed a project to develop the evidence-based knowledge and logic for three potential CDS recommendations. Three topics, discussed in the 2011 IOM report, were chosen by NIOSH for development: 1) diagnosis and management of an occupational disease (work-related asthma); 2) consideration of work environmental factors in managing a chronic disease (diabetes); and 3) guidance for return-to-work for conditions, whether they are work-related or not.

Preparation of the evidence-based information and logic (contained in the knowledge resources) was completed by three groups of occupational health subject matter experts (SMEs), one for each topic. The SMEs were identified by three different established and recognized professional associations (American College of Occupational and Environmental Medicine, American Thoracic Society, and Association of Occupational and Environmental Clinics). The professional organizations served solely as administrative coordinators of the work of the identified SMEs; the SMEs provided their expertise and were not representing the associations.

In the fall of 2014, NIOSH brought together the SMEs for a face-to-face meeting and provided them with guidance, methods, and tools available to help convert guidelines and knowledge about best practices into computer-implementable recommendations. One of the authors (RS) provided informatics expertise and support for the SMEs as they conducted a critical review of existing, relevant guidelines and best practices for their content area, then synthesized the knowledge using approaches described above, drawing on the BRIDGE-Wiz and eGLIA applications. Although the general topics were chosen by NIOSH, each SME

work group proposed and developed specific clinical recommendations for implementation of their topic. Over the next year, the SME work groups prepared knowledge resources⁹¹⁰¹¹ [http://www.acoem.org/uploadedFiles/Public_Affairs/Policies_And_Position_Statements/Guidelines/Library_and_Reference_Material/NIOSH%20Final%20Reports.pdf] that could serve as the basis for future electronic CDS for PCPs. The work involved identifying, reviewing and summarizing the current scientific literature and professional clinical treatment guidelines for the given topic and converting this information into specific recommendations, including the decision logic for triggering delivery of the decision support. Details of the methods used by each SME work group are described in their respective papers.

To generate CDS that would be meaningful to PCPs, we engaged researchers from Oregon Health & Science University (OHSU) and conducted a qualitative evaluation study at five primary care practices in the summer of 2015. We obtained Institutional Review Board (IRB) approval from NIOSH, OHSU, and each local site as required. We used versions of the three knowledge resources that had been prepared up to that point. Results of the qualitative evaluations were provided to the three SME work groups for revision and refinement of their final knowledge resources. Details of this activity is found in the paper by Baron et al.¹²

RESULTS

The process described above successfully generated knowledge resources that were accepted by primary care practices (PCPs and staff, including health information system implementers) as potentially useful and feasible in their settings. The IOM Committee provided three scenarios that frequently challenge PCPs in practice. SMEs identified relevant clinical practice guidelines and best practices, narrowed the scope of the clinical problem, and developed one recommendation that could be supported by electronic CDS. Reviews with PCPs, staff, and health information system implementers in primary care settings confirmed that the approach was operationally sound and important to them.

The articles in this compilation describe the process conducted by each group of SMEs to prepare evidence-based knowledge and decision logic for the three recommendations. The paper by Harber et al.¹³ describes an approach for work-related asthma triggered by a diagnosis of asthma or emergency room, acute clinic visit, or hospitalization for asthma in an adult in the past two years.¹³ Allen et al.¹⁴ describe the process of developing a recommendation around recognition of factors at work that impact diabetes care and management among working adults, triggered by an HbA1c laboratory value.¹⁴ The paper by McLellan et al.¹⁵ describes development of an activity prescription tool to assist with return-to-work associated with acute low back pain not caused by work, triggered by a request or requirement from a patient for an activity note.¹⁵ Lastly, the paper by Baron et al.¹² describes the input obtained from PCPs and staff at five heterogeneous and geographically dispersed primary care practices regarding the proposed CDS.¹²

DISCUSSION

The accompanying articles in this special compilation provide examples for how clinical recommendations linked to work can be introduced as CDS in primary care settings. The initial feedback on the knowledge resources suggests that adding this information to current health information systems is feasible and that PCPs find the information useful and appreciate assistance to better consider the role of work in their patient's care.

The importance of the role of PCPs in recognizing and managing occupational issues was noted by the IOM in 1988,¹⁶ the American College of Physicians in 1990,¹⁷ and some researchers in the American Academy of Family Physicians journal, *American Family Physician*, in 1998 and 2010.^{18,19} Specific conditions directly related to work often present themselves in that setting first.¹⁶ PCPs also provide care under workers' compensation. Using data from the National Ambulatory Medical Care Survey, Won and Dembe²⁰ found that family physicians provided care for patients with work-related conditions at 22% of visits nationally; an additional 9% were seen by internal medicine physicians.²⁰ However, the visits to family physicians represented only a small proportion (2.5%) of their total office visit load.

Providers frequently care for patients who may be having trouble managing their health at work, and patients whose health affects their ability to work, yet may not recognize the potentially important role that work plays in their patients' illness, injury and recovery.^{21,22} The patient-centered medical home (PCMH) has been widely embraced to deliver comprehensive and coordinated care "to improve the patient experience, improve population health, and reduce the cost of care."²³ Successful implementation requires recognition of social determinants of health. In recognition of the link between health and work, The Joint Commission recently included work history in the elements of the clinical record of a PCMH.²⁴ The knowledge resources referenced in the accompanying compilation of articles provide a starting point for improving the use of work information in the primary care encounter. At the start of this process, we were aware of no previous systematic development and assessment of the feasibility and usefulness of delivering clinical information linked to work through health information systems for primary care settings.

For the full development of new CDS tools, once implementable and evidence-based decision support recommendations are developed, the recommendations must be fully formalized into a representation that can be incorporated into CDS software. The final step—localization of the guidance—is performed at a local level, where the CDS is tailored to the needs and resources, workflow, technical capabilities and design preferences of the CDS system users. The NIOSH project did not undertake localization in the work reported in this compilation but these additional activities will be essential before any of these suggested knowledge resources can be implemented in a primary care practice.

CONCLUSION

Despite recognition that PCPs address the interface of work and health, effective training in this area is largely absent from the medical curriculum, leaving a gap in knowledge about

clinical care of workers.²⁵ CDS relating work and health, delivered by health information systems affords an opportunity to address this knowledge gap by providing targeted and relevant information during a clinical encounter. Such decision support has the potential to improve clinical care and raise awareness about the importance of the work environment to patients' health. The improved awareness could result in a feedback loop of more consistent consideration of patient work in patient care.

Acknowledgments

Support: This work was performed and funded by the CDC, National Institute for Occupational Safety and Health, NORA project #927ZLDN, and included Intergovernmental Personnel Act (IPA) agreements with Dr.'s Baron and Shiffman to support their participation.

The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the Centers for Disease Control and Prevention.

REFERENCES

1. Campbell RJ. The five rights of clinical decision support: CDS tools helpful for meeting meaningful use. *J AHIMA*. 2013;84:42–7.
2. US Bureau of Labor Statistics. Table A-3. Employment status of civilian non-institutional population by sex and age, seasonally adjusted. Employment and Earnings Online; 2016; 63 (12). Washington, DC: Bureau of Labor Statistics. Available at: https://www.bls.gov/opub/ee/2016/cps/tablea3_201611.pdf. Accessed January 4, 2017.
3. Bureau of Labor Statistics. News Release No. USDL16–2130: Nonfatal Occupational Injuries and Illnesses Requiring Days Away From Work, 2015. 2016; Washington, DC: Bureau of Labor Statistics Available at: <http://www.bls.gov/news.release/pdf/osh2.pdf>. Accessed January 10, 2017.
4. Dunstan DW, Thorp AA, Healy GN. Prolonged sitting: Is it a distinct coronary heart disease risk factor? *Curr Opin Cardiol*. 2011;26:412–9. [PubMed: 21785350]
5. Howard J Nonstandard work arrangements and worker health and safety. *Am J Ind Med*. 2017;60:1–10. [PubMed: 27779787]
6. Institute of Medicine. Incorporating occupational information in electronic health records: Letter report. Washington, D.C: The National Academies Press; 2011 Available at: <http://www.nationalacademies.org/hmd/Reports/2011/Incorporating-Occupational-Information-in-Electronic-Health-Records-Letter-Report.aspx>
7. Shiffman RN, Michel G, Rosenfeld R, Davidson C. Building better guidelines with BRIDGE-Wiz: a software assistant to promote quality, transparency, and implementability. *J am med inform assoc*. 2012;19:94–101 [PubMed: 21846779]
8. Shiffman RN, Dixon J, Brandt C. The GuideLine Implementability Appraisal (GLIA): development of an instrument to identify obstacles to guideline implementation. *BMC Med Inform Decis Mak*. 2005;5:23. [PubMed: 16048653]
9. Work-Asthma Domain Experts (WADE) Final Report. Submitted by the Work Asthma Domain Expert Committee: Phillip Harber, MD, MPH, chair; Stella Hines, MD, MSPH; Carrie A. Redlich, MD, MPH; Joe Gerald, MD, Ph.D; Eileen Storey, MD, MPH; Margaret Filiros, RN, MS. January 2016. Produced under contract 212–2014-M-59016. Available at: http://www.acoem.org/uploadedFiles/Public_Affairs/Policies_And_Position_Statements/Guidelines/Library_and_Reference_Material/NIOSH%20Final%20Reports.pdf.
10. Final knowledge report for the Diabetes Subject Matter Expert Group. Submitted by the Diabetes Subject Matter Expert Group: Laura Welch, MD (chair); Anna Allen, MD, MPH; Douglas Trout, MD, Sherry Baron, MD, MPH; Katherine Kirkland, DrPH, MPH. December 2015. Produced under contract 212–2014-M-59011. Available at: http://www.acoem.org/uploadedFiles/Public_Affairs/Policies_And_Position_Statements/Guidelines/Library_and_Reference_Material/NIOSH%20Final%20Reports.pdf.

11. Using Electronic Health Records and Clinical Decision Support to Provide Return-to-Work Guidance for Primary Care Practitioners for Musculoskeletal Conditions Not Caused by Work. NIOSH Return-to-Work Subject Matter Expert Panel – Final Report. NIOSH RTW Subject Matter Expert Panel: Robert K. McLellan, MD, chair; Nelson S. Haas, MD; Roman P. Kownacki, MD; Glenn S. Pransky, MD; James B. Talmage, MD. November 2015. Produced under contract 212–2014-M-59014. Available at: http://www.acoem.org/uploadedFiles/Public_Affairs/Policies_And_Position_Statements/Guidelines/Library_and_Reference_Material/NIOSH%20Final%20Reports.pdf.
12. Baron S, Filios MS, Marovich S, Chase D, Ash JS. Recognition of the Relationship between Patients' Work and Health: A Qualitative Evaluation of the Need for Clinical Decision Support for Worker Health in Five Primary Care Practices. *J Occup Environ Med*. 2017; Not Yet Published (NYP)
13. Harber P, Redlich CA, Hines S, Filios M, Storey E. Recommendations for a Clinical Decision Support System for Work Related Asthma in Primary Care Settings. *J Occup Environ Med*. 2017; NYP
14. Allen A, Welch L, Kirkland K, Trout D, Baron S. Development of a Diabetes Mellitus Knowledge Resource for Clinical Decision Support-Assisting Primary Care Physicians with Work-Related Issues. *J Occup Environ Med*. 2017; In press.
15. McLellan RK, Haas NS, Kownacki RP, Pransky GS, Talmage JB, Dreger M. Using Electronic Health Records and Clinical Decision Support to Provide Return-to-Work Guidance for Primary Care Practitioners for Patients with Low Back Pain. *J Occup Environ Med*. 2017; NYP
16. Institute of Medicine. Role of the Primary Care Physician in Occupational and Environmental Medicine. Washington, D.C: The National Academies Press;1988 Available at: <https://www.nap.edu/catalog/9496/role-of-the-primary-care-physician-in-occupational-and-environmental-medicine>.
17. ACP. Occupational and environmental medicine: the internist's role. American College of Physicians Position Paper. *Ann Intern Med*. 1990;113:974–82. [PubMed: 2099759]
18. Lax MB, Grant WD, Manetti FA, Klein R. Recognizing occupational disease – taking an effective occupational history. *Am Fam Physician*. 1998;58:935–44. [PubMed: 9767728]
19. Taiwo OA, Mobo BHP, Cantley L. Recognizing occupational illnesses and injuries. *Am Fam Physician* 2010;82:169–74. [PubMed: 20642271]
20. Won JU, Dembe AE. Services provided by family physicians for patients with occupational injuries and illnesses. *Ann Fam Med*. 2006;4(2):138–147. DOI:10.1370/afm.515 [PubMed: 16569717]
21. Walker B, Adenuga B, Mouton C. The Relevance of Occupational Medicine to Primary Care in the 21st Century. *J Natl Med Assoc*. 2011;103:306–12. [PubMed: 21805809]
22. Harber P, Mullin M, Merz B, Tarazi M. Frequency of Occupational Health Concerns in General Clinics. *J Occup Environ Med*. 2001;43:939–45. [PubMed: 11725333]
23. Hing E, Kurtzman E, Lau DT, Taplin C, Bindman AB. Characteristics of primary care physicians in patient-centered medical home practices: United States, 2013 National health statistics reports; no. 101, Hyattsville, MD: National Center for Health Statistics, 2017.
24. The Joint Commission (TJC). Record of Care (RC) Standard.02.01.01, Element of Performance (EP) #28. Comprehensive Manual for Ambulatory Health Care. CAMAC Update 2015.
25. Landrigan PJ, Baker DB. The recognition and control of occupational disease. *JAMA*. 1991;266:676–80. [PubMed: 2072478]